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ASW 3-20-02

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TITLE OF INVENTION

Tilt-steered rolling device

CROSS-REFERENCE TO RELATED APPLICATIONS

Related U.S. Application: None

Related Non-U.S. Application:

Nonprovisional patent application about the same invention, German Patent Office (Deutsches Patent- und Markenamt), Application date: 12/06/2000.

Title: Mehrspuriges neigungsgelenktes Rollgeraet.

IPC: A63C 17/00. Patent reference No: P10060663

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

REFERENCE TO A MICROFICHE APPENDIX

Not Applicable

BACKGROUND OF THE INVENTION

This invention relates to rolling devices that allow individuals to move forwards or backwards such as roller skates, inline skates, skateboards, scooters, skis on wheels, wheel chairs, tricycles etc. Roller skates and skateboards are known which provide two non-tiltable wheel pair mechanisms, one at each end, wherein the platform can be tilted sideways and the wheels steer responding to the tilt by making the mechanisms swivel, having upwardly and downwardly angled swivel axes, thereby changing the direction in which the wheels are pointing.

Usually small extra-wide cylindrical wheels are used that cause undesirably high friction. Upon tilting, the mass acceleration forces are directed off the midline of the wheels' tracks, loading the wheels unequally and finally limiting the maximum tilt angle. Inline skates, however, tilt as a whole, comprising the known low friction narrow wheels, but cannot be tilt-steered.

DE19803412A1 discloses tiltable and tilt-steered wheel supports, wherein the wheels are fixed to longitudinal guides, the latter functioning as a compound guide system based on two sets of longitudinal fourfold linked chains. Any such solution using longitudinal guides is technically complex. Another problem is that such a solution causes unequal loading on the wheels of each pair.

The latter disadvantage was overcome by using cross-guides. WO85/03644A1 describes wheels affixed to holders, which are guided using cross-guides in order to form a parallelogram-like chain having two sets of four links. The entire system is pivotally secured to a base plate, where the pivot axis extends vertically with respect to this base plate, just like a bogie. Steering is coupled to the tilt by a rack and pinion mechanism with the rack attached to the base plate. This solution still requires many parts and is complex.

BRIEF SUMMARY OF THE INVENTION

A principal objective of the present invention is to provide a novel steering mechanism to be used in wholly tiltable rolling devices wherein the steering angle is coupled to the tilt angle in a simple and kinematically well defined manner. Another major objective of this invention is to provide a steering mechanism which distributes the radial load equally on the wheels comprised by this mechanism. A further important objective of this invention is to provide a steering mechanism which uses only a few simple or easily manufactured parts or which uses standard components. It is another major objective of the

invention to create a rolling device which beyond its tilt-steering capacity has little friction and damps vibrations.

These and other advantages are attained as follows. Assume a multi-tracked tilt-steered rolling device which incorporates pairs of tiltable wheels wherein the wheels are guided in form of a parallelogram. The simple steering mechanism described by the present invention comprises generally two obliquely swiveling cross-guides 5, 6. Their swivel axes are 9a, 9b. These two cross-guides 5, 6 attach pivotably to two separate wheel holders 4a, 4b where the pivot axes 7a, 7b of the first cross-guide 5 and the pivot axes 7c, 7d of the second cross-guide 6 are preferably oriented longitudinally and parallel, in a way that the known parallelogrammic link chain is formed. One wheel 3a is rotatably affixed to one wheel holder 4a and the other wheel 3b is rotatably affixed to the other wheel holder 4b. The two cross-guides 5, 6 are allowed to swivel with regard to the platform, their swivel axes being 9a, 9b. Alternatively the axial swivelling (9b) is replaced by and included in a universally swivelling capacity which is provided by a universal joint 12 which attaches to the platform. The kinematics of the whole mechanical system is then well defined, preserving the freedom of tilt. The oblique swivel axis 9a of the first cross-guide 5 is at an angle α (alpha) with respect to the pivot axes 7a, 7b, 7c, 7d. This angle, called the steering factor angle influences the capability of the rolling device to be tilt-steered.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. 1 is a front view of a skate in the upright (FIG. 1a) and in the tilt-steered (FIG. 1b) positions.

FIG. 2 is a front view of the invented tilt-steering parallelogrammic link chain in the tilted position.

FIG. 3 is a front view of the preferred embodiment of the invented parallelogrammic link chain carrying the wheel pair, in the upright position.

FIG. 4 is a side view of this embodiment.

FIG. 5 is a side view of a skate which incorporates three wheels.

FIG. 6 is a side view of the tilt-steering mechanism fitted with a suspension.

FIG. 7 is an exploded perspective view of part of the tilt-steering mechanism.

FIG. 8 is an enlarged view of a possible embodiment of the universal joint which connects the cross-guides with the extensions of the platform.

FIG. 9 is a detailed view of another embodiment showing the spring used to return the mechanism into the neutral position.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. 1 the directions which the wheel pair 3a, 3b and the guiding wheel 16 take, are equal and coincide with the longitudinal axis of the platform 2. FIG. 1b illustrates in the same general manner the tilted position of the skate, showing that the wheels are tilted as well, and showing also that the wheels 3a, 3b of the wheel pair have a steering angle with respect to both the platform 2 and the guiding wheel 16. FIG. 3 shows the front view of a parallelogrammic link chain, which consists of the two wheel holders, left 4a and right 4b, and the two cross-guides, the first on top, 5, and the second below, 6. The parallelogrammic link chain, described by its four pivot axes 7a, 7b, 7c, 7d is rectangular, as shown in FIG. 3, or is a non-rectangular parallelogram, as shown in FIG. 2. The invention also includes the possibility that the four axes define a trapezium (not drawn).

FIGS. 2, 3 and 4 illustrate how the steering mechanism works. As the cross-guide 5 according to the invention is swiveling, with the swivel axis 9a inclining obliquely by an angle α (alpha) with respect to the set of pivot axes 7a, 7b, 7c, 7d of the link chain, the tilting of the platform 2 and its extensions 8a, 8b with respect to the cross-guide 5 will cause

the end of the cross-guide 5 revealed in FIG. 2 by partially cutting away extension 8a, to swivel out of the center plane of the platform 2. The other end of cross-guide 5 swivels to the other side. This results in a steering angle which increases as the tilt angle increases. As the two wheels 3a, 3b are connected with two wheel holders 4a, 4b, which are themselves part of the link chain comprising also the two cross-guides 5 and 6, the link chain transfers the steering angle to the wheels 3a, 3b so that the rolling device follows a curved track. The kinematics is shown in FIG. 2, viewed in the direction of the axes 7a, 7b, 7c, 7d. The platform 2 is then seen at a shallow perspective angle.

Although FIGS. 2 to 6 anticipate that the axes 7a, 7b, 7c, 7d are oriented longitudinally with respect to the rolling device and are oriented parallel to the ground, this is not necessarily a prerequisite of the present invention. The essential condition for ensuring the tilt-steering function is the presence of an angle α (alpha, steering factor angle) which is described by the intersection of the parallel set of pivot axes 7a, 7b, 7c, 7d and the parallel set of swivel axes 9a, 9b.

Shown in FIG 7. are the two cross-guides 5, 6, the right wheel holder 4b, one wheel 3b and its bolt and axle 11b. The respective symmetrical wheel and wheel holder from the left side are omitted. The cross-guide 5 incorporates a bridge 5b which has a cross-sectional area large enough to ensure high torsion stiffness. In this embodiment the cross-section of the bridge 5b is a triangle. The preferred embodiment of the invented obliquely swiveling parallelogrammic link chain contains six links, where the first cross-guide 5 has four holes and the second cross-guide 6 has two holes. Six bolts (three bolts 21 are shown in FIG. 7) or axles connect the two cross-guides 5, 6 with the two wheel holders 4a, 4b which accordingly have three eyeholes each to accommodate said six bolts or axles. These six links pivotally connecting the cross-guides with the wheel-holders can easily be designed in a way which is common and well

known to a person skilled in the art. Steel bolts can also be combined with standard cylindrical bearings made from brass or plastic, which fit into the eye-holes (not drawn).

Referring to FIG. 5 the rolling device is able to steer along a curved track if the device has rotatably affixed to the platform at least one guiding wheel 16 which has a distance r (wheel base) to the wheels 3a, 3b of the wheel pair. Another parallelogrammic wheel pair mechanism can be used instead of the one guiding wheel 16. Its steering factor angle α (alpha) may be designed to be zero. In this case this wheel pair does not steer. The device's ability to curve is only determined by the steering function of the wheel pair mechanisms whose steering factor angles are not zero.

The invented obliquely swiveling parallelogrammic link chain mechanism only consists of a few simple parts. Design components can be cheaply molded, formed or machined. Materials used may include light metal such as aluminum or other strong or reinforced (e.g. glass or carbon fiber resin) plastic.

Certain applications e.g. roller skates, require the wheels to be placed underneath the platform 2. Upon tilting the platform, one wheel of the wheel pair 17 moves upwards approaching the platform 2, and the other wheel moves away from it. The space between the wheels and the platform needed for this movement increases with both the maximum tilt angle and the track width s between the two wheels 3a, 3b of the wheel pair. In order to minimize the space required i.e. to avoid an excessive "high-heeled" design, it is desirable to design the track s to be as small as possible. As can be seen in FIG. 2 the lateral space between the two parallelogrammically guided wheels reduces upon tilting. In addition, space is required for affixing the wheels' axles 11a, 11b. This additional space can be reduced, if necessary, if the said axles are fixed to the wheel holder only from the outer side of the wheels. However, the single sided wheel axle fixation is an optional feature.

An embodiment is preferred, in which the wheels' rotation axes are kept parallel. This is achieved by making the distance between the pivot axis 7a and the pivot axis 7b of the first cross-guide 5 the same as the distance between the pivot axis 7c and the pivot axis 7d of the second cross-guide 6.

If, upon tilting, the track width alters, at least one of the two wheels 3a, 3b will slide sidewards on the ground, causing friction and wear. An embodiment is therefore preferred which stabilizes the track, avoiding friction or wear, by having the distance between the pivot axes 7a and 7b of the first cross-guide 5, which is equal to the distance between the pivot axes 7c and 7d of the second cross-guide 6, made now equal to the track width s by design. This means that the pivot axes 7a and 7c lie in the center plane of wheel 3a and the pivot axes 7b and 7d lie in the center plane of the other wheel 3b.

The present invention is compatible with a design, e.g. where each of the two cross-guides 5, 6 has a cylindrical bored hole, both parallel to each other but obliquely oriented with respect to the set of pivot axes 7a, 7b, 7c, 7d where the said holes serve to accommodate axles to be affixed to extensions 8a, 8b of the platform. This embodiment is possibly kinematically over-defined, as (in brief) the two cross-guides are forced to move in a parallel orientation by two independent mechanisms, first by the said two axles, secondly by the parallelogrammic link chain, both mechanisms possibly interfering with each other, if design tolerances are unfavorable. In order to avoid such interference, an embodiment is preferred wherein only one cross-guide 5 is supplied with a swivel axis 9a as mentioned, affixing this swivel axis 9a at extensions 8a, 8b of the platform 2, but supplying the second cross-guide 6 with a universal joint 12, e.g. in form of a spherical bushing, a ball-head bearing or the like, connecting the cross-guide 6 with the extension 8a of the platform 2 using the said universal joint 12 (see FIG. 4).

This invention may also imply that the swivel axis 9a is directed obliquely with respect to most of the component parts' edges and faces. Technically any skew angled drilling, washers, axles etc. cause considerably high manufacturing costs. The preferred embodiment saves costs, as it ensures the function of an oblique swivel axis combined with hole drilling to be simply perpendicular to the part surfaces by use of universal joints 13a, 13b. The obliquity of the swivel axis 9a is ensured by designing a (preferably) vertical offset h in placing the two universal joints 13a and 13b at the first cross-guide 5. Altogether the universal joints 12, 13a, 13b can now fit into drilled holes, which are at right angles to the surfaces of the cross-guides 5, 6 and extensions 8a, 8b of the platform 2. The swivel axis 9a is now defined by the straight line through the centers of the two said universal joints 13a, 13b. Another advantage of using universal joints instead of full-length axles is that the full-length axle produces space restrictions due to the limited track width condition. This is shown in FIG. 3 and FIG. 4. It is noted that the universal joint 12 of the second cross-guide 6 should preferably be vertically offset with respect to the middle of its pivot axes 7c, 7d and that the said offset in millimeters (mm) equals the vertical offset in mm of the universal joint 13a of the first cross-guide 5 with respect to the middle of its pivot axes 7a, 7b.

FIG. 8 shows how parts can be connected using a spherical bushing as universal joint. A threaded bolt 22 having a cylindrical portion is placed through the spherical bushing 12, 13a, or 13b. The parts to be connected are the cross-guide 5 resp. 6 with extension 8a resp. 8b of the platform 2. The bolts 22 have design axes 14a, 14b, 14c.

Many rolling devices like roller skates or scooters need to be functionally right-left symmetrical. This symmetry is preferably realized by having the oblique swivel axis 9a lie in the longitudinal vertical symmetry plane of the device, i.e. triangle 7c, 7d, 14c and triangle 7a, 7b, 14a are isosceles

triangles. As the center parallel line 7m between axes 7a and 7b is lying within the symmetry plane, there exists a point K where the axes 9a and 7m intersect.

One of the objects of this invention is to avoid swiveling of the wheel pair out of the center line upon tilting. The wheels 3a, 3b of the wheel pair will, upon tilt, stay within the center line, if by design the said intersection point K is positioned vertically above the common axis of the axles 11a, 11b, as shown in FIG. 4.

Certain rolling devices, e.g. roller skates, are alternatively lifted of the ground and put back down again. When touching the ground, one wheel grips first, initiating the tilt-steering action. Finally the second wheel of the wheel pair touches down, stabilizing the tilt-steered curve. During this short interval the steering function is not defined. An embodiment is preferred which ensures that the device, e.g. a roller skate, assumes a neutral position i.e. the upright non-tilted position, see FIG. 1a, when lifted from the ground. This objective is met by introducing a flexing means, which returns or maintains the wheel pair in the neutral position using the force of this flexible material or of a spring. FIG. 9 shows an embodiment, wherein a preformed spring wire 15 is affixed at the extension 8a, acting on the cross-guide 5 so that it is forced to assume the desired position. A multitude of alternative design possibilities exist, which are easily found by a person skilled in the art.

FIG. 5 illustrates that the device additionally incorporates a wheel 16 which is affixed longitudinally at a certain distance, the wheel base r, in order to be able to be steered. Alternatively another tilt-steering wheel pair which is designed according to this invention can be affixed. The curve radius depends on the steering factor angles α (alpha), which pertain to the one or two tilt-steering mechanisms. It also depends on the wheel base r. The curve radius becomes small when by design the angles α (alpha) are chosen to be large and the wheel base r

is small. For this new tilt-steering skates, α (alpha) may range from 0.05 to 0.2 radian to be useful. The wheel base r may range from 20 to 35 centimeter, dependent on the preferred use of the skate. For example the designer of high speed skates may allow for smooth long curves. The mentioned ranges for α (alpha) and r are not meant to exclude other values. It is just this variability which opens ways to commercialize a wide variety of rolling devices specifically intended for different uses.

The most economic embodiment of the invention combines one tilt-steered wheel pair with one fixed wheel. Embodiments are preferred where the tilt-steering wheel pair is arranged at the rear end of the device and the single wheel is affixed at its front end and vice versa.

If four wheels are preferred because of improved weight distribution or because of better tracking then a preferred embodiment would combine two tilt-steering wheel pairs 17 affixed at either end of the rolling device. It is to be noted that the rearmost affixed wheel pair should have its swiveling axis 9a be designed to be declining, and that the front wheel pair should have its swiveling axis 9a be designed to be inclining, both viewed from behind. An alternative cheap four-wheels embodiment within the scope of this invention is defined by the combination of one tilt-steering wheel pair with one pair of wheels in-line, both pairs being affixed at opposite ends of the rolling device (not drawn).

If the preferred use of the invented rolling device implies its use on rough surfaces, suspension and damping qualities are desired in order to protect the ankles and to keep the device on track. A suspension with or without damping can be realized by affixing the tilt-steering wheel pair 17 in such a manner to the platform, that it can be shifted essentially at a right angle to the platform and by introducing a springy element into the space reserve needed for shifting. Regarding the compound consisting of the parallelogrammic mechanism including its wheel pair and the extension 8a, 8b the function of the extensions 8a, 8b is

now perceived to be separated from the platform, being designed as a separate part 8b e.g. being attached to the platform 2 with a hinge 18; see FIG. 6. The space between part 8c and the platform 2 offers room for affixing springy elements 19, like a rubber cushion, a pressurized gas cushion, a helical coil or a leaf spring. The damping property can be realized e.g. by filling viscous material into a bellows, using elastomers or applying cheap standardized oil dampers. A person skilled in the art is familiar with such a design requirement. For example, DE19715706A1 discloses appropriate features, describing technical solutions for non-steering wheel suspensions which can also be applied to tilt-steering mechanisms like the one invented here.

The use of rolling devices as invented are used at an increased level of safety, if, as known, a brake is attached to it. As shown in FIG. 7, a rubber block 20 attached at the rear of the platform serves this objective.